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(54) **Process for manufacturing bodies of polymeric material, comprising a core of foamed material enclosed by outer shell, and device used in said process**

Verfahren zur Herstellung von Gegenständen aus Polymermaterial bestehend aus einem geschäumten Kern mit einer umhüllenden Schale, und Vorrichtung für dieses Verfahren

Procédé pour fabriquer des objets en matière polymère comprenant un noyau en mousse entouré d'une enveloppe extérieure, et dispositif utilisé pour ce procédé

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Description

The present invention relates to a process for manufacturing bodies of polymeric material by means of the blow-molding technique, in particular to provide bodies comprising a core of foamed material enclosed by an external shell.

Such bodies normally display a rigid structure and good properties of heat insulation, such as to make the use thereof for such household electrical appliances, as refrigerators, and the like, particularly advantageous. At present, the technique of blow-molding is used in order to manufacture a hollow shell of thermoplastic material, inside which a thermosetting foam is subsequently injected, for example a polyurethane foam obtained by means of the well-known RIM technology. Such an operating way shows problems both in terms of possibility of finished article recycling, and in terms of environmental pollution by the foaming agent.

In fact, the chemical nature of the foamed polyurethane core makes it impossible the manufactured article to be recycled, and the chloro-fluoro-alkane foaming agent normally used in RIM technology causes problems of interaction with ozone present in stratosphere. Furthermore, the execution of the process according to the technology known from the prior art as two different steps (blow-molding and subsequent foam injection) causes the production cycle to be rather slow and expensive.

US-A-3, 901,958 describes a method for producing bodies comprising a hollow core of foamed material enclosed by an external shell, in which a two-layer parison comprising a foamable material and the material forming the external shell is extruded into a pressurized chamber and the parison is inflated to conform with the shape of the mold. The chamber is then de-pressurized to cause the expansion of the foamable material.

US-A-3,378,612 describes an apparatus for producing bodies having a core of a foamed material enclosed by an external shell, wherein a prefoam material is injected into a tubular parison and pressure is used to shape the parison. As the pressure is released, the prefoam expands to fill the cavity of the mould.

The purpose of the present invention is of supplying a process of the type as specified in the introduction to the specification, which does not display the above said drawbacks and which is simple and cheap to be carried out.

According to the invention, such a purpose is achieved by a process for manufacturing bodies comprising a core of foamed material enclosed by an external shell by means of the blow-molding technique, in which the blowing is performed by injecting into the interior of a hollow thermoplastic body a foamable thermoplastic polymeric material suitable for bringing the walls of the hollow body into contact with the walls of a mold. This process is characterized in that the injected foamable material contains a physical foaming agent

selected from CO₂, N₂ and hydrocarbons, and it is injected extremely quick in a time in the order of 2 seconds and in that the shaping of the hollow body, conforming to the walls of the mold is obtained by expansion of the foamable material.

By "foamable thermoplastic polymeric material" any thermoplastic material mixed with said foaming agent are meant. It is evident that, as in the traditional blow-molding technology, the hollow extruded body (parison) is at a temperature close to the polymer softening temperature, and anyway such as to secure the "blowing" of the hollow body. This feature is particularly advantageous in the case of the present invention, because the foamed thermoplastic material (which also is at a temperature which is close to the polymer softening temperature) can be thermowelded to the walls of the hollow body, thus making it possible a structurally resistant manufactured article to be obtained. A further advantage of the present invention relates to the possibility of using a same polymeric material, or materials belonging to the same polymeric family, for both the foamed core and the external shell, making it possible the manufactured article to be recycled at the end of its useful life time. The process according to the present invention makes it also possible the production cycle to be speeded up, as compared to the traditional technology of blow-molding and subsequent foaming of the cooled hollow shell.

A further purpose of the present invention is providing a device for carrying out the above said process.

Such a device, of the type which comprises an extruder with accumulation chamber suitable for cyclically extruding a tubular parison between two mobile half-molds facing each other, is characterized in that said device also comprises a second extruder for a polymeric material admixed with said foaming agent, and an auxiliary accumulation chamber into communication with said second extruder, and equipped with an injection nozzle centrally installed relatively to a ring-shaped nozzle for tubular parison extrusion.

Further advantages and characteristics of the process and device according to the invention will be clear from the following disclosure in detail, supplied for merely exemplifying, non-limitative, purposes, by referring to the accompanying drawings, in which:

Figures 1, 2, 3, 4 display four sequential steps of a process according to the present invention, Figure 5 shows a longitudinal sectional view of a manufactured article produced by means of the process according to the invention, and Figure 6 shows a longitudinal sectional view of a device according to the present invention.

Referring to the drawings, with the reference numeral 1 the end portion of an extruder for a compact polymeric material, such as, e.g., polypropylene, is indicated. The extruder 1 is fastened onto a main body 3, to

which the end of a second extruder 2 for a foamable polymeric material, such as, e.g., polypropylene admixed with CO₂, N₂, hydrocarbons, is also fastened. The first extruder 1 is in communication with an annular accumulation chamber 4, inside which the compact material accumulates; said chamber 4 is coaxial with a central cylindrical accumulation chamber 10 for the foamable material. The annular accumulation chamber 4, the volume of which is adjustable, is equipped with an annular ram 5 actuated, by means of stems 5a, by a hydraulic jack 18a, to feed a determined amount of molten polymer to a ring-like extrusion die 6. The jack 18a is interposed between a mobile plate 17 fastened onto the end of the stems, and a fixed plate 12 integral with body 3.

In an analogous way, the central accumulation chamber 10, connected with the second extruder by means of a channel 8, is equipped with a self-cleaning ram 9 actuated by a jack 18b through a central stem 9a. The ram 9 delivers under pressure, through a valve 11, a determined amount of foamable polymeric material, in the plastic state, centrally to the ring-like die 6. The free opening of the latter is furthermore adjustable by means of a jack 18c which, by means of stems 7a, changes the position of an end plate 7, relatively to the central portion, i.e., the core portion, of the ring-like die 6.

Under the latter, a mold is installed, which comprises two self-shearing half-molds 15 opposite to each other, and suitable for being frontally locked to each other, so as to define a hollow. Each half-mold 15 is furthermore provided, at its bottom end, with a mobile insert 16 suitable for translating, relatively to the same half-mold, in a direction which is the same direction of closure of the half-molds 15, in the way which is better explained in the following.

Referring to Figure 1, a tubular parison 13 of thermoplastic material is extruded through the die 6, under desired conditions of temperature and pressure, into the room comprised between both half-molds 15. At the end of the step of extrusion of the tubular parison 13, the latter is closed in its bottom portion, by means of the two inserts 16 which, during said step of the process, translate integrally with the half-molds 15 according to a transversal direction to parison 13 extrusion direction (Figure 2). Then, into the interior of the tubular parison 13, closed at its bottom, the foamable polymeric material 14 present inside the central accumulation chamber 10, is injected (Figure 3). The injection of the foamable material into the interior of the tubular parison is performed according to a sequential, extremely quick, operation of opening of valve 11, actuation of ram 9 and closure of valve 11.

The foamable material, owing to the low pressure existing inside the interior of the parison, can freely foam urging the walls of the parison 13 against the walls of half-molds 15 -- which in the meanwhile can be locked to each other -- and to conform to said walls (Figure 4). During the foaming step, the foam acts as the tubular parison shaping means. During such a step, the

closure of the two half-molds 15, and the shearing action performed by the mobile inserts 16 (urged by springs 16a interposed between the insert and the relevant half-mold) causes the piece indicated in Figure 5 with the reference character P to be peripherically sheared; said piece P, after suitable cooling, can be demolded.

In order to improve the forming step, the annular hollow room comprised between the parison and the mold walls can be advantageously depressurized.

Example 1

This test was carried out by using the equipment displayed in Figure 6.

A polypropylene marketed by Company Himont under the trade name Moplen[®] SP 98/E, having a melt index of 0.7 g/10 minutes, was fed to the extruder (1) having a diameter of 120 mm, and a screw length : diameter ratio = 30.

Polypropylene was extruded at a flowrate of 150/h, with a corresponding screw revolution speed of 30 rpm.

At the extruder screw end (1) values of pressure of 140 bars (2000 lb/p²), and a temperature of molten polymeric mass of 210°C were measured.

Through a heated fitting, the molten polymer enters then the accumulation chamber (4), which has a maximal volume of 9 litres.

To the extruder (2) a compound was fed which consisted of 100 parts of a polypropylene marketed by Company Himont under the trade name Profax HMS PF 814, having a melt index of 2.5 g/10 minutes, 1.0 parts of "Hydrocerol[®] Compound" ex Boehringer, and 0.5 parts of zinc stearate.

The extruder (2) is of double screw type with co-revolving screws, having a diameter of 90 mm and a length:diameter ratio = 16.6.

Into the extruder, a mixture of isobutane and butane in the ratio of 30:70 was directly injected into the molten polymeric mass, at a distance from the feed point of approximately 1/3 of the total extruder length.

The hydrocarbon mixture was injected with a flow-rate equivalent to 7 percent by weight, based on the weight of polypropylene resin.

The molten mass constituted by the polymer, the additives and the gas, intimately mixed with one another, passes from an homogenization temperature of approximately 215°C to an extruder leaving temperature of 160°C.

From the extruder, the polymer/foaming agent mixture runs through a heated feed channel, going to fill the accumulation chamber (10), having a maximal inner volume of 4 litres.

The pressure value as measured at the extruder screw end was of 100 bars.

When the filling of both accumulation chambers was completed, the process was continued according to the operating steps as illustrated in Figures from 1 to 5.

From the accumulation chamber (4) a tubular parison is extruded, which has a diameter of 500 mm and an average thickness of 4 mm.

The length of tubular parison was fixed as 1.3 metres.

The conditions of molten polymer flowrate adopted in parison extrusion were of 1.2 kg/second, equivalent to a falling axial speed of 13 m/min.

After causing both mobile inserts (16) installed in the bottom portion of both half-molds to come into contact with each other in order to "weld" in that area the tubular parison of material, still in the molten state, into the parison the polymer/foaming agent mixture contained inside the accumulation chamber (10) was injected.

Said foamable mixture leaves from the closure valve (11), having a circular cross-section of 12 mm of diameter, at a flowrate of 2 160 kg/hour.

The injection time was of 2 seconds, to which an amount of injected foamable mixture of 1.2 kg corresponds.

Simultaneously to the injection of the foamable mixture, both half-molds (15) close, to form a hollow having a parallelepipedal shape of dimensions of 600x1100x50 mm.

The resulting end product is a structural body which reproduces the dimensions of the hollow, characterized by an outer layer of compact polypropylene, coming from extruder (1), having an average thickness of 3.5 mm, and an inner core of foamed polypropylene having a density of 35 kg/m³.

Example 2

The instant test was carried out by using the same equipment as illustrated in Figure 6, and operating according to the procedure as disclosed in Example 1.

To extruder (1), a polystyrene was fed, which is marketed by Company Enichem Polimeri under the trade mark Edistir SRL 800, having a melt index of 3.5 g/10 minutes, at a flowrate of 180 kg/hour, for a corresponding screw revolution speed of 25 rpm.

To extruder (2), a compound was fed, which consisted of 100 parts of a polystyrene marketed by Company Enichem Polimeri under the trade name Edistir N 1380, having a melt index of 3.0 g/10 minutes, 0.5 parts of "Hydrocerol® Compound" ex Boehringer, and 0.2 parts of zinc stearate.

The foaming agent used was the same mixture of butane:isobutane 70:30 of Example 1 with a flowrate equivalent to 6 percent by weight, based on the weight of polystyrene resin.

The pressure value measured at the end of extruder screw was of 160 bars, with a temperature of the molten mass of 145°C.

The conditions adopted in extrusion of parison were the same as of Example 1, with the diameter of the opening of the closure valve (11) being increased from

12 to 20 mm, in order to keep the injection flowrate of foamable mixture unchanged (2 160 kg/hour, to which, during a time of 2 seconds, an injected amount of 1.2 kg corresponds).

The end product obtained is an integrally polystyrene structural body with an outer compact layer of 3.5 mm of thickness, and an inner foamed core having a density of 35 kg/m³.

10 Claims

1. Process for manufacturing bodies comprising a core of foamed material enclosed by an external shell by means of the blow-molding technique, in which the blowing is performed by injecting into the interior of a hollow thermoplastic body a foamable thermoplastic polymeric material, characterized in that the injected foamable material contains a physical foaming agent selected from CO₂, N₂ and hydrocarbons, and it is injected extremely quick in a time in the order of 2 seconds and in that the shaping of the hollow body, conforming to the walls of the mold is obtained by expansion of the foamable material.

2. Process according to claim 1, characterized in that it comprises the following steps:

- two mobile half-molds (15) are pre-arranged facing to each other,
- a substantially tubular thermoplastic parison (13), is extruded between said half-molds (15),
- both half-molds (15) are closed onto the parison (13), in order to define a hollow comprised between the walls of parison (13) and the walls of mold (15),
- into the inside of the parison (13) a thermoplastic polymeric material is injected, which contains a physical foaming agent suitable for causing said parison to blow, in a plastic condition, inside the above said hollow, until the parison walls come into contact with and conform to, said mold walls, the injection time being extremely quick in the order of 2 seconds, and
- the manufactured article (P) is removed from mold (15, 16).

3. Process according to claim 1 or 2, characterized in that the polymeric material used for the parison (13) is substantially identical to the foamable polymeric material (14).

4. Device for manufacturing finished articles of polymeric material provided with a core of foamed material enclosed by an external shell, of the type which comprises an extruder (1) with accumulation chamber (4) suitable for cyclically extruding a tubular parison (13) between two mobile half-molds (15)

facing each other, characterized in that said device also comprises a second extruder (2) for a polymeric material admixed with a physical foaming agent selected from CO₂, N₂ and hydrocarbons and an auxiliary accumulation chamber (10) into communication with said second extruder (2), and equipped with an injection nozzle (11) centrally installed relatively to a ring-shaped nozzle (6) for tubular parison (13) extrusion.

5. Device according to claim 4, characterized in that said accumulation chamber (4) displays a ring-like shape and is co-axial with the auxiliary accumulation chamber (10).
6. Device according to claim 4 or 5, characterized in that said mobile half-molds are provided, at their bottom end, with sliding inserts (16) suitable for sealing said parison (13), at its bottom end, before said mold is closed.

Patentansprüche

1. Verfahren zur Herstellung von Gegenständen durch das Blasformverfahren, die einen Kern aus geschäumtem Material, umschlossen von einer äußeren Schale, umfassen, wobei das Blasformen durch Spritzen eines thermoplastischen polymeren Materials in das Innere eines thermoplastischen Hohlkörpers ausgeführt wird, dadurch gekennzeichnet, daß das eingespritzte verschäumbare Material ein physikalisches Treibmittel, ausgewählt aus CO₂, N₂ und Kohlenwasserstoffen, enthält und äußerst schnell in einem Zeitraum in der Größenordnung von 2 Sekunden eingespritzt wird, und daß das Formen des Hohlkörpers, der an den Wänden der Form anliegt, durch Ausdehnen des verschäumbaren Materials erfolgt.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß es die nachstehenden Schritte umfaßt:
 - zwei bewegliche Formhälften (15) werden vorher so angeordnet, daß sie zueinander weisen,
 - ein im wesentlichen röhrenförmiger thermoplastischer Hohlkörperrohling (13) wird zwischen den Formhälften (15) extrudiert,
 - beide Formhälften (15) schließen sich an dem Hohlkörperrohling (13), um einen zwischen den Wänden des Hohlkörperrohlings (13) und den Wänden der Form (15) umfaßten Hohlraum zu definieren,
 - ein thermoplastisches polymeres Material, das ein physikalisches Treibmittel enthält, welches den Hohlkörperrohling im plastischen Zustand innerhalb des vorstehend genannten Hohlraums auftreiben kann, wird in das Innere des

Hohlkörperrohlings (13) gespritzt, bis die Wände des Hohlkörperrohlings mit den Wänden der Form in Kontakt treten und anliegen, wobei die Einspritzzeit äußerst schnell in der Größenordnung von 2 Sekunden liegt, und

- der hergestellte Gegenstand (P) wird aus der Form (15, 16) entnommen.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das für den Hohlkörperrohling (13) verwendete polymere Material mit dem verschäumbaren polymeren Material (14) im wesentlichen identisch ist.

4. Vorrichtung zur Herstellung von fertigen Gegenständen aus Polymermaterial, die mit einem Kern aus geschäumtem Material, umschlossen von einer äußeren Schale, versehen sind, von der Art, die einen Extruder (1) mit einer Sammelkammer (4), geeignet für zyklisches Extrudieren eines röhrenförmigen Hohlkörperrohlings (13) zwischen zwei beweglichen Formhälften (15), die zueinander weisen, umfaßt, dadurch gekennzeichnet, daß die Vorrichtung auch einen zweiten Extruder (2) für ein polymeres Material, angemischt mit einem physikalischen Treibmittel, ausgewählt aus CO₂, N₂ und Kohlenwasserstoffen, und eine Hilfssammelkammer (10) in Verbindung mit dem zweiten Extruder (2) umfaßt und mit einer Spritzdüse (11), mittig angeordnet in bezug auf eine ringförmige Düse (6), zur Extrusion des röhrenförmigen Hohlkörperrohlings (13) ausgestattet ist.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Sammelkammer (4) eine ringähnliche Form zeigt und mit der Hilfssammelkammer (10) koaxial ist. -
6. Vorrichtung nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die beweglichen Formhälften an ihrem unteren Ende, mit gleitenden Einsätzen (16) versehen sind, geeignet zum Abdichten des Hohlkörperrohlings (13) an dessen unterem Ende, bevor die Form geschlossen wird.

Revendications

1. Procédé pour fabriquer des objets comprenant un noyau en matériau alvéolaire entouré par une enveloppe extérieure entourée au moyen de la technique du moulage par soufflage. dans lequel le soufflage est réalisé en injectant à l'intérieur d'un corps thermoplastique creux un matériau polymère thermoplastique moussant (susceptible de prendre une structure alvéolaire), caractérisé en ce que le matériau moussant injecté contient un agent physique moussant choisi parmi CO₂, N₂ et les hydrocarbures et est injecté de façon extrêmement

rapide en une durée de l'ordre de deux secondes et en ce que le formage du corps creux, se conformant aux parois du moule est obtenu par dilatation du matériau moussant.

2. Procédé selon la revendication 1, caractérisé en ce qu'il comporte les étapes suivantes consistant :

- à pré-agencer deux demi-moules mobiles (15) l'un en face de l'autre, 10
- à extruder une paraison thermoplastique (13) sensiblement similaire entre lesdits demi-moules (15).
- à fermer deux demi-moules (15) sur la paraison (13), afin de définir un creux compris entre les parois de paraison (13) et les parois du moule (15). 15
- à injecter à l'intérieur de la paraison (13) un matériau polymère thermoplastique, qui contient un agent physique moussant approprié pour obliger ladite paraison à gonfler, dans un état plastique, à l'intérieur dudit creux ci-dessus, jusqu'à ce que les parois de la paraison viennent en contact avec lesdites parois de moule, et se conforment à ces parois de moules, la durée d'injection étant extrêmement courte, de l'ordre de deux secondes, et 20
- à enlever l'article manufacture (P) du moule (15, 16). 25

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que le matériau polymère utilisé pour la paraison (13) est sensiblement identique au matériau polymère moussant (14). 30

4. Dispositif pour fabriquer des articles finis en matériau polymère, munis d'un noyau en matériau alvéolaire, entouré par une enveloppe extérieure, du type qui comporte une extrudeuse (1) avec une chambre d'accumulation (4) appropriée pour extruder de manière cyclique une paraison tubulaire (13) entre deux demi-moules mobiles (15) situés l'un en face de l'autre, caractérisé en ce que ledit dispositif comporte également une deuxième extrudeuse (2) pour un matériau polymère admis avec un agent physique moussant choisi parmi CO_2 , N_2 et les hydrocarbures, et une chambre d'accumulation auxiliaire (10) en communication avec ladite deuxième extrudeuse (2) et équipée d'une buse d'injection (11) installée centralement par rapport à une buse (6) de forme annulaire pour l'extrusion de la paraison tubulaire (13). 35 40 45 50

5. Dispositif selon la revendication 4, caractérisé en ce que ladite chambre d'accumulation (4) présente une forme annulaire et est coaxiale à la chambre auxiliaire d'accumulation (10). 55

6. Dispositif selon la revendication 4 ou 5, caractérisé en ce que lesdits demimoules sont munis, à leur extrémité de fond, d'inserts coulissants (16) appropriés pour sceller de façon étanche ladite paraison (13), à son extrémité de fond, avant que ledit moule ne soit fermé.

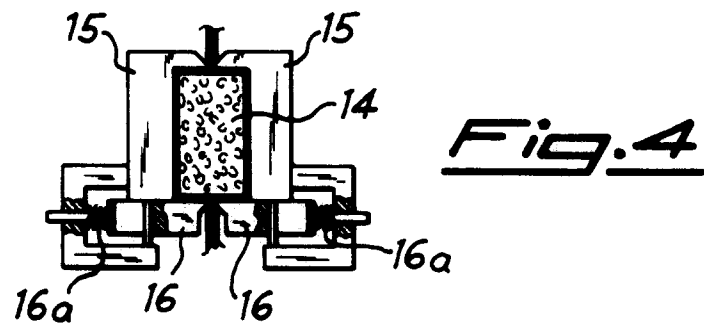
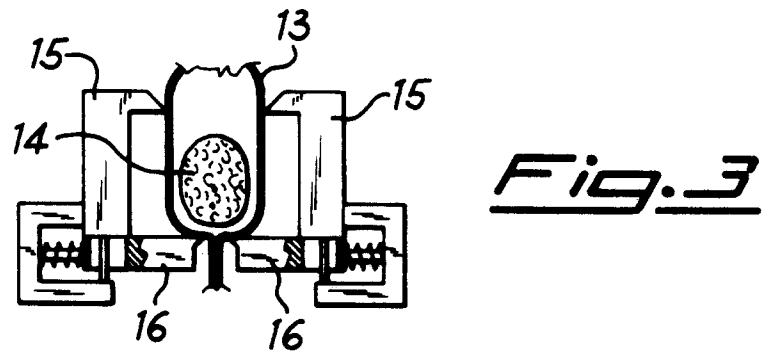
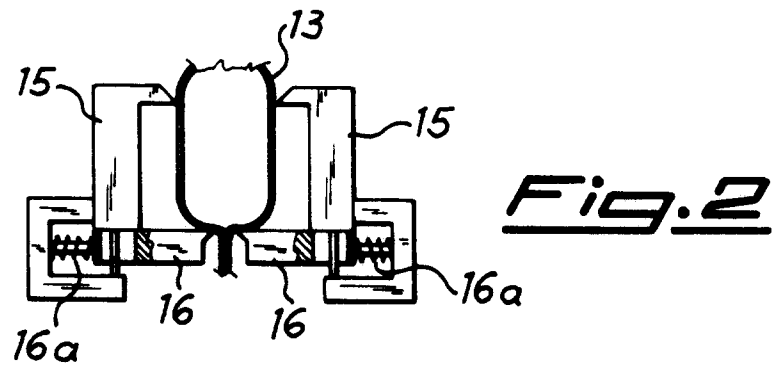
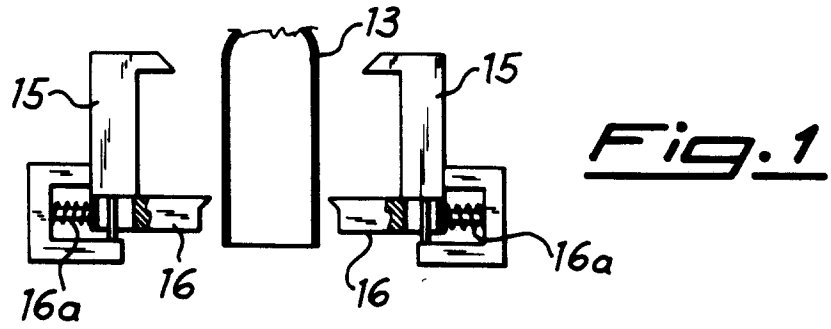


Fig. 6

